REMARKS

Election/Restrictions

Applicants elect group I (claims 1-168, 211, 212, 217 and 218) with traverse. During a telephone conversation with the examiner on December 18, 2002, Applicants made a provisional election of group I with traverse.

Claim Objections

The examiner has objected to claims 212 and 218 as dependent upon a non-elected claim. Claim 218 has been canceled because, as amended, it is believed that claim 218 would be a substantial duplicate of amended claim 212. Claim 212 has been amended to independent form. Applicants respectfully request allowance of rewritten claim 212.

Claim Rejection - 35 U.S.C. §112

The examiner has rejected claims 23-43, 58-66, 81-89, 95-104, 110-124, 129-140, 145-152 and 157-168 under 35 U.S.C. §112, second paragraph. Specifically, the examiner states the following:

(a) Claims 23-43, 58-66, 81-89, 110-124, 129-140, and 157-168 recite hardness in units of "GPa," wherein the claims and the specification fail to clearly establish what method of testing is used to determine the hardness. The examiner states that the specification remains silent to the type of testing and one of ordinary would not recognize "GPa" as indicating a particular hardness from the known prior art.

Response

Applicants traverse on the ground that the rejection is not proper under 35 U.S.C. § 112 because "one skilled in the art would understand all language in the claims when read in light of the specification, as the claims must be." *Rosemount, Inc. v. Beckman Instruments, Inc.*, 221

U.S.P.Q. 1, 7 (Fed. Cir. 1984), citing *Caterpillar Tractor Co. v. Berco, S.P.A.*, 219 U.S.P.Q. 185 (Fed. Cir. 1983). The examiner has not established that persons of ordinary skill in the art would not recognize "GPa" (giga pascal) as a unit of hardness. *See* Appendix 1, Zhiyong Li, et al. *On Two Indentation Hardness Definitions*, 154 SURFACE AND COATINGS TECHNOLOGY 124, 130 (2002). Applicants respectfully request that this rejection be withdrawn.

(b) Claims 95-104 and 145-152 recite, "said sufficient quantity", but do not provide antecedent basis for the limitation "sufficient quantity." The examiner states that it is unclear what quantity is being limited because the term does not appear previously in the claim. Claims 95-104 and 145-152 have been amended to include "lubricous outer surface." The amendments do not change the scope of the claims, but simply state what was originally intended. Claims 95-104 and 145-152 are in condition for allowance.

Applicants respectfully request allowance of all claims dependent upon the above claims.

Claim Rejection - 35 U.S.C. §102

Yuan et al.

Claim 211 is rejected under 35 U.S.C. §102(b) as being anticipated by Yuan et al. U.S. Patent No. 5,676,701 (Yuan). Claim 211 has been canceled.

Davidson

Claim 217 is rejected under 35 U.S.C. §102(b) as being anticipated by Davidson U.S. Patent No. 5,415,704 (Davidson). The examiner states that Davidson teaches a Cr-containing medical implant material containing Cr. The examiner states that Davidson teaches a chromium coating and a means for increasing the initial hardness of the chromium coating, citing Col. 10, ll. 11-50; and Example 1.

Response

In order to establish a case of *prima facie* anticipation, the examiner must establish that a prior art reference discloses every limitation of the claimed invention either explicitly or inherently. *Atlas Powder Co. v. Ireco Inc.,* 190 F.3d 1342, 1346, 51 USPQ2d 1943, 1945 (Fed. Cir. 1999). Applicants note that claim 217 is a "means plus function" claim. Claim 217 defines "forming a hard chromium coating" as "providing a chromium coating having an initial hardness; and **means for** increasing said initial hardness." Claim 217 (emphasis added). The examiner is required to read the foregoing "means-plus-function" portion of claim 217 " to cover the corresponding structure, material, or acts described in the specification and equivalents thereof." 35 U.S.C. § 112(6). "The 'broadest reasonable interpretation' that an examiner may give means-plus-function language is that statutorily mandated in paragraph six. Accordingly, the PTO may not disregard the structure disclosed in the specification corresponding to such language when rendering a patentability determination." *In re Donaldson Co.*, 16 F.3d 1189, 29 USPQ2d 1845 (Fed. Cir. 1994).

The present application teaches that:

> The bulk hardness of chromium nitride is about 11 GPa. **Carbon atoms are more effective for hardening a chromium coating or a chromium alloy substrate than nitrogen atoms** because carbon atoms are larger and diffuse less rapidly than nitrogen atoms and thus, at a given temperature, cannot segregate so easily to form a second phase carbide precipitate. **The local strain introduced into the chromium lattice by introduction of carbon or carbide precipitates is greater than the corresponding local strain for nitrogen precipitates**. It is this increased local strain that impedes the movement of dislocations and thereby hardens the material. Furthermore, the precipitates formed by carbides will be smaller than those formed by nitrides under comparable conditions. As a result, **the precipitates formed by carbides are more likely to be in an optimum size range of from about 10 atomic % to about 30 nm**--a size range of precipitates which maximizes coherency strain and mechanical interaction with any dislocation(s) moving through the chromium lattice. In steel tempered below 300°C, the monoclinic Hägg carbide, $Fe_{2.2}C$, is formed and is very effective in hardening mechanisms. Another strengthener at low

concentrations is $Fe_{2.3}C_5$. Chromium forms a similar range of carbides to those of iron.

> Preferably a sufficient amount of carbon is chemically reacted with the chromium to increase the hardness of the coating to about 15 GPa or more, more preferably about 20 GPa or more, even more preferably to about 25 GPa or more. In order to achieve this level of hardness, the final coating content is preferably from about 10 atomic % to about 30 atomic % carbon in relation to the chromium content, preferably about 20 atomic % carbon in relation to the chromium content.

Specification at page 10, lines 1-22 (emphasis added). According to the present application, a chromium coating or chromium alloy substrate is bombarded with "an energetic beam of ions of the additive comprising, most preferably carbon monoxide ions." Specification at page 8, lines 5-7. Upon impact with the metal surface, the CO^+ ions "dissociate with momentum shared between the carbon and oxygen ions," and "once equilibrium is reached, stable carbides and oxides of chromium are formed." Specification page 8, line 22 to page 9, line 1 (emphasis added).

The examiner has not met his burden to point to a teaching or suggestion of a chromium coating or a chromium alloy substrate bombarded with "an energetic beam of ions." Davidson teaches:

> [t]his invention provides methods to strengthen and harden an alloy's surface and includes (1) an internal oxidation process which includes **adding** a low concentration of a more readily oxidizable solute such as yttrium, niobium, tantalum, zironium, thorium, hafnium, **chromium**, or aluminum to the alloy, and oxidizing a portion of the solute that is found immediately beneath the metal surface; (2) an internal nitridization process which includes adding low levels of a relatively more nitridable solute such as zirconium, silicon or thorium to the alloy and nitriding a portion of this solute that is found just below the metal surface; and (3) an additional interstitial diffusion strengthening process using nitrogen, oxygen, or carbon.

Col. 5, ll. 31-51 (emphasis added). Davidson also teaches that the interstitial diffusion strengthening process "is used on implants which have previously been treated with an internal oxidation or nitridization treatment." Col. 2, ll. 23-25. The examiner has not pointed to a

teaching or suggestion in Davidson of an **ion implantation** process, much less a process in which a chromium coating or a chromium alloy substrate is bombarded with "an energetic beam of ions of the additive" comprising carbon and oxygen, "most preferably carbon monoxide ions" to form "stable carbides and oxides" of the coating or alloy chromium atoms. Thus, the examiner has not pointed to a teaching or suggestion in the Davidson patent of claim 217's "means for increasing said initial hardness," as that phrase must be construed under 35 U.S.C. §112(6), and the examiner has not established that Davidson anticipates claim 217. Applicants respectfully request that the examiner withdraw the rejection of claim 217 under 35 U.S.C. §102.

Claim Rejection - 35 U.S.C. §103

Davidson (5,415,704)

Claims 1, 5-9, 16, 20-25, 35-43, 72-77, 90-93, 95-101, 104-108, 110-121, 125, 129-131, and 141-168 are rejected under 35 U.S.C. §103(a) as being unpatentable over Davidson U.S. Patent No. 5,415,704. The examiner contends that "the process steps taught by the reference are the same as the process steps recited in the claims (i.e. treating the surface with an additive comprising oxygen and/or carbon (col 2, lines 33-46))." The examiner also states that "one of ordinary skill in the art would expect that the products resulting from the process taught by the reference would be the same as the product resulting from applicant's claimed process, including the product's coefficient of friction and chromium oxide/carbide gradient."

Response

Claims 1, 90, 125 and 141 have been canceled and claims 239-242 have been added. A person of ordinary skill in the art would have recognized, from reading the specification, that the original claims were directed to the subject matter of claims 239-242. Claims 239-242 simply make explicit that which was inherent in claims 1, 90, 125 and 141.

"To support the conclusion that the claimed invention is directed to obvious subject matter, either the references must expressly or impliedly suggest the claimed invention or the examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references." *Ex parte Clapp*, 227 USPQ 972, 973 (Bd. Pat. App. & Inter. 1985). The examiner has not pointed to a teaching or suggestion in the Davidson patent of all the limitations of claims 239-242. *In re Vaeck*, 20 U.S.P.Q.2d 1438, 1442 (Fed. Cir. 1991).

Claims 239-241 are directed to treating a substrate "**selected from the group consisting of a chromium coating and a chromium alloy**." Claim 239 is further directed to treating a substrate "with an additive comprising an element X under conditions effective to react X with said substrate chromium atoms." Claim 240 is further directed to treating a substrate "with an additive comprising oxygen under conditions effective to produce a mixture . . . said mixture comprising substrate molecules and chromium-oxide molecules comprising said substrate chromium atoms." Claim 241 is further directed to treating a substrate "with an additive comprising an element selected from the group consisting of oxygen, carbon, and a combination thereof under conditions effective to produce a final surface . . . comprising substrate molecules and molecules selected from the group consisting of chromium oxide, chromium carbide, and a combination thereof, wherein said chromium consists essentially of said substrate chromium atoms." In addition, claim 242 is directed to treating a "substrate comprising a surface comprising substrate chromium atoms . . . with an additive comprising oxygen under conditions effective to produce a mixture . . . comprising substrate molecules and chromium-oxide molecules consisting essentially of said substrate chromium atoms."

In contrast, Davidson teaches an internal oxidation process, including "adding a low concentration of a more readily oxidizable **solute** such as . . . chromium . . . to the alloy, and oxidizing a portion of the **solute** that is found immediately beneath the metal surface." Col. 5, ll. 35-40. Thus, the examiner has not pointed to a teaching or suggestion in the Davidson patent of the limitations of claims 239-242, as described above. *In re Vaeck*, 20 U.S.P.Q.2d 1438, 1442 (Fed. Cir. 1991).

Nakahama et al. (5,882,439)

Claims 1-2, 4-10, 14-17, 19-28, 32-48, 55-66, 72-77 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Nakahama et al. U.S. Patent No. 5,882,439.

Response

The examiner has not pointed to a teaching or suggestion in the Nakahama patent of all the limitations of claims 239-242, as discussed above. *In re Vaeck*, 20 U.S.P.Q.2d 1438, 1442 (Fed. Cir. 1991). Nakahama et al. teaches chromization "on a **Ni- or Co-base heat-resistant alloy**" and "preferably performed by the solid- or gas-phase procedure" (*see* Col. 3, ll. 64-67), using the following sequence:

"(1) in the atmosphere of treatment, Cr is liberated and precipitated out of the Cr halide by reduction with hydrogen;

(2) the fine particles of Cr that has thus precipitated out are deposited on a surface of the member being treated; and

(3) the deposited fine Cr particles will diffuse into the member being treated."

(emphasis added) Col 4., ll. 37-44. The Nakahama patent also teaches a "post-heat treatment such as stabilization or aging so as to restore the mechanical properties of the base material." Col. 4, ll. 60-61. The post-heat treatment "may occasionally oxidize part of the chromium

diffusion layer or cause dechromization or, alternatively, chromium may diffuse further into the base material." Col. 4, ll. 62-65. Thus, the examiner has not pointed to a teaching or suggestion in the Nakahama patent for treating a substrate "**selected from the group consisting of a chromium coating and a chromium alloy**," as described in claims 239-241. Nor has the examiner pointed to a teaching or suggestion in the Nakahama patent for treating a "substrate comprising a surface comprising substrate chromium atoms . . . with an additive comprising oxygen under conditions effective to produce a mixture . . . comprising substrate molecules and chromium-oxide molecules consisting essentially of said substrate chromium atoms." Thus, the examiner has not established prima facie obviousness over Nakahama et al.

Davidson (5,676,701) in view of Sinderband (2,685,543)

Claims 94, 102, 103, 109, 122-124, 126-128 and 132-140 have been rejected under U.S.C. §103(a) as being unpatentable over Davidson in view of Sinderband.

Response

Applicants explained above why the examiner has not established prima facie obviousness over Davidson. The argument applies equally to the 35 U.S.C. §103(a) rejection over Davidson in view of Sinderband.

Sinderband teaches:

> a **ferrous body** or article having at least in the surface layer thereof at least about 0.4 percent available carbon is provided with a wear-resistant continuous surface layer of chromium carbide having a Vickers hardness of at least about 1500 to 1600, by causing chromium — deposited at an elevated temperature on the surface of the body from a gaseous or liquid chromium compound — **to diffuse into the surface layer of the ferrous body and to combine with the carbon content thereof to produce a wear-resistant chromium surface layer** of a thickness of at least about 8 microns having such high hardness.

Col. 1, ll. 23-36 (emphasis added). Sinderband further teaches:

it is also possible to provide ferrous bodies or articles which have a low carbon content with a wear-resistant chromium carbide layer by first forming on the surface thereof, by a known **carburizing process**, a carburized surface layer or casing of high carbon content, and thereafter subjecting the so **carburized surface region** to the chromium deposition and chromium carbide forming treatment.

Col. 6, ll. 4-13. Thus, the examiner has not pointed to a teaching or suggestion in Sinderband that would motivate a person of ordinary skill in the art to modify Davidson to treat a substrate "**selected from the group consisting of a chromium coating and a chromium alloy**," as described in claims 239-241. *In re Brouwer*, 37 U.S.P.Q.2d 1663, 1666 (Fed. Cir. 1995). Nor has the examiner pointed to any teaching or suggestion in Sinderband that would motivate a person of ordinary skill in the art to modify Davidson to treat a "substrate comprising a surface comprising substrate chromium atoms . . . with an additive comprising oxygen under conditions effective to produce a mixture . . . comprising substrate molecules and chromium-oxide molecules consisting essentially of said substrate chromium atoms." For all of the foregoing reasons, the examiner has not established a case of *prima facie* obviousness.

CONCLUSION

For all of the foregoing reasons, Applicant respectfully requests reconsideration and allowance of all of the pending claims.

Respectfully submitted,

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